SCIENCE

FRIDAY, NOVEMBER 23, 1888.

THE MOST CASUAL READER of magazines and reviews cannot have failed to notice the increasing share of attention being given by them to educational matters. The *Century* has honored the memory of Dr. Edward Thwing, and described Uppingham School; it has also given space to a discussion of manual training and to other school subjects. The *Atlantic Monthly* printed in a prominent position President Eliot's suggestions as to how the school courses might be enriched and shortened. And now comes the *Nineteenth Century*, which, in its November issue, gives the post of honor to a document which, it is safe to say, will rank as one of the most important and significant of modern times. It is a protest against the sacrifice of education to examination, and is signed by several hundred of the most prominent and influential men and women in Great Britain. We notice in the long list the names of Professor Bryce, Henry Bradlaugh, Lord Lytton, Grant Allen, Prof. J. S. Blackie, Oscar Browning, Canon Creighton, Edward A. Freeman, Edmund Gosse, Frederic Harrison, Dr. James Martineau, Frederick Pollock, G. J. Romanes, Professor Westcott, Lionel Beale, Dr. Crichton-Browne, Sir Morell Mackenzie, Sir Edwin Arnold, Mrs. E. Lynn Linton, and Miss Charlotte M. Yonge.

The document records the "strong protest of the signers against the dangerous mental pressure, and misdirection of energies and aims, which are to be found alike in nearly all parts of our educational system. Alike in public elementary schools, in schools of all grades and for all classes, and at the universities, the same dangers are too often showing themselves under different forms. Children are treated by a public department, by managers and schoolmasters, as suitable instruments for earning government money; young boys of the middle and richer classes are often trained for scholarships with as little regard for the future as two-year old horses are trained for races; and young men of real capability at the universities are led to believe that the main purpose of education is to enable them to win some great money prize, or take some distinguished place in an examination. We protest most emphatically against such a misdirection of education, and against the evils which necessarily arise from it." The resulting evils are then specified in detail and at some length. They are classified as physical, intellectual, and moral. The *Nineteenth Century* prints, together with the protest, comments on it by Prof. Max Müller, by Professor Freeman, and by Frederic Harrison. Professor Müller recalls the fact that he was, forty years ago, an ardent supporter of a system of examinations for the civil service. He now sees that this has been carried too far, and the fault has been, not with the application of the principle of examination, but with the principle itself. Mr. Harrison's paper is the most pungent and practical of all. He points out that "examination, having been called in to aid education, has grown and hardened into the master of education. Education is becoming the slave of its own creature and servant. I do not deny that examination has its uses; I do not say that we can do without it. I say that it is a good servant, but a bad master; and, like good servants turned bad masters, it is now bullying, spoiling, and humiliating education."

It will be interesting to notice how much attention this important paper attracts in this country, and how much influence it will have with these slaves of routine and examinations, our old-fashioned schoolmasters. There are men who regard the examination as sacred, and not to be touched or altered, and there are systems, that of New York City, for example, that are built upon a vicious examination system as a foundation. Some time since, we called the attention of the readers of *Science* to this examination question, and printed some valuable articles on the subject. We can only hope that our American teachers will listen to the voice of England's experience, and take some steps that will make such a protest both unnecessary and impossible in the United States.

THE QUESTION WHETHER the growth of forests causes an increase of rainfall is both a scientific and an economic one; and as not only in this country, but also in Europe, great corporate or private interests are to be affected by its decision, much of the discussion of it, unfortunately, has not been of a purely scientific character. It has not been carried on for the purpose of arriving at the truth, but to sustain some proposition asserted in advance to be true. It has been what Professor Henry would have called 'debate' as distinguished from 'discussion.' In Europe there is a great outcry among the common people against the maintenance of forests over such great areas for the preservation of game and to promote the personal pleasures of a few nobles, while the peasants are starving for the want of land to cultivate. But the nobles reply, that, if the forests are cut down, the rainfall will be diminished, the lands that are now fertile will become barren, so that the common people will be worse off than ever; and they send forth their well-paid scientific men to establish stations, make investigations, and prove the truth of this proposition. We do not mean to say that scientific men in Europe consciously prostitute themselves in this way,—they earnestly seek the truth, and do so with much learning and diligence, — but, so often has it been asserted that the growth of forests promote rainfall, that it has almost become an axiom in science as well as among the people; and the results of any investigations that seem to sustain it are of necessity more readily entertained than those which point to the converse. An interesting account of the latest and the most thorough examination of a small area for the purpose of solving this question is given in the abstract of Professor Fernow's paper, read before the Philosophical Society of Washington at a recent meeting. In this country many of the great railroad corporations have vast areas of land to sell in the Far West. They desire to induce Eastern people to go there, settle on these lands, and build up cities and towns, so that the business of their lines may be increased. But an idea prevails in the East that the best lands have already been occupied; that the rainfall beyond the present line of civilization is either so small, or so unevenly distributed throughout the year, as to make the successful production of a crop a matter of great uncertainty; and they hesitate. But the agents of the railroad companies reply that the climate of the Far West has changed; that the planting of trees upon what was once arid lands has increased the amount of rainfall, and caused a more equal distribution of the water in the streams; so that now lands that were once unfit for cultivation have become fertile, and certain to produce crops every year; and they quote figures to prove it. Fortunately there are men engaged in the investigation of this subject who have no interests to serve but the discovery of the truth; and *Science*, in its present issue, presents contributions to this branch of the discussion by two men of this class. The truth can be reached only after a thorough discussion.

THE INFLUENCE OF FORESTS ON THE QUANTITY AND FREQUENCY OF RAINFALL.

THE effect of the growth of forests on rainfall is receiving fresh attention in the Philosophical Society of Washington. At a recent meeting of that society Professor Fernow of the Department of Agriculture gave an historical review of the experiments made in Europe during the present century to determine the influence of forests on the quantity and frequency of rainfall. When the reading of Professor Fernow's paper was concluded, there was no time for the discussion of it, and a symposium on the subject was arranged for the next meeting. Mr. Henry Gannett opened the discussion, and his address was the most notable of the evening. He was followed by others, notably by Gen. A. W. Greely, who has made this subject a special study. That part of Professor Fernow's paper relating to the experiments in Europe are given here, followed by Mr. Gannett's remarks in full.

Professor Fernow's Paper.

I wish to call attention to the latest, most important, in fact the only scientific work, it seems to me, which has been done to establish the important but difficult question of the influence of forests on precipitation. I refer to the work of Dr. F. J. Studnika, professor of mathematics at the University of Prague, published under the title 'Basis for a Hyetography of Bohemia,' in which the results of many years of observation at 700 ombrometric stations are embodied, critically sifted, and scientifically considered.

The work of ombrometric observations, although begun in Bohemia during the last century, was newly organized in 1879 or 1880, when a systematic net of ombrometric stations was instituted; and in 1885 and 1886 it was extended over 700 stations, for the purpose of obtaining accurate data of the quantity and distribution of precipitation over the kingdom. Uniform ombrometers were used and very carefully placed. As at present organized, there is one station for every seventy-five square kilometres (about thirty square miles). No other country, I believe, can boast of such a service. Although the time of observation at most stations has been short, and the average would have been more accurately represented by an extension of observations for ten or twelve years, yet the last four years of observation, for which all stations furnish data, according to the author, represent two extreme and two average years, and are therefore quite useful.

The very large mass of material permitted a sifting-out of doubtful observations without impairing the number available for the construction of a rain-map of Bohemia, showing by isohyetal lines seven rain-belts or zones. The zones are so arranged that the lowest shows less than 500 millimetres rainfall, the three following differ by 100 millimetres each, the fifth and sixth by 200 millimetres, and the seventh by 300 millimetres; showing, therefore, a rainfall of 1,200 to 1,500 millimetres.

The central basin divides itself into halves by a line from north to south, running somewhat east of the middle Moldau, crossing the Elbe near the mouth of the Iser, and following the latter river; the western half showing the smaller amount of precipitation, namely, 500 to 600 millimetres; the eastern, with 600 to 700 millimetres, continuing in a small belt along the foot of the Erzebirge and the Boehmer-wald, encircling the first zone.

The other isohyetal lines do not embrace continuous areas, but follow in small belts the trend of the mountains. The larger amounts of precipitation are found in belts or islands in the higher altitudes of the mountains which surround this great basin. The continuity of the zones is much interrupted, so that it would be difficult to describe it without a map.

The maximum rainfall with over 1,200 millimetres is observed in the south near the sources of the Moldau and Wotawa; in the north, near the sources of the Elbe, Iser, and Aupa, on the range of the Schneekoppe. In regard to the distribution through the months, the experience has confirmed, that, with increasing absolute height, the winter precipitation increases in greater proportion than that of the summer, while those of spring and autumn are nearly equal.

Sufficient material was on hand from which to calculate the influence of altitude on the increase of precipitation, although for altitudes above 500 metres the material is not considered sufficiently accurate. Yet the general law is well shown, that with the altitude the quantity of precipitation increases in a retarded progression. This progression is calculated by forming altitude zones from 100 to 100 metres, grouping the stations in each, calculating the mean elevation and also the mean annual precipitation as observed for each class; then, by dividing the difference of precipitation in two neighboring zones by the difference of altitude, the amount of precipitation which corresponds to each one metre of elevation within that class is found. With this figure, the average amount of rainfall which theoretically belongs to each station according to its absolute elevation can be approximated by adding to or subtracting from the mean precipitation of the class as many times this amount as the actual altitude differs from the mean.

A single example will make this clear. Tetschen, for instance, is situated 150 metres above the sea-level. According to the table, the average elevation of 13 stations of the lowest zone, to which Tetschen belongs, is 182 metres, with an average precipitation of 506 millimetres. Now, as Tetschen has an elevation of 32 metres lower than the average, the rainfall should be $32 \times .79 = 25.4$ millimetres less than the mean of the class; hence, theoretically, according to its altitude, the quantity of rainfall for Tetschen should be $506 - 25.4 = 480.6$ millimetres; that is, 248 millimetres less than that actually found in an eight-years' average.

By using the figures for the two extreme zones and dividing by 100, the mean increase of precipitation for every 100 metres elevation is found to be 69 millimetres.

And now comes the application of this method to our proposition. The author argues that if the actually observed rainfall differs considerably from the theoretical, this is an indication that special agencies are at work.

He finds now, that, of 186 stations which he subjects to scrutiny (those offering the longest and most trustworthy observations), 48 show a considerable difference between the observed and the theoretically expected rainfall, and he finds also that these stations are situated in the most densely wooded portions of the kingdom.

The increased rainfall at the 48 stations is so considerable, that sufficient quantity may be ascribed to other local causes, as, for instance, height and form of a mountain-range in front or back, etc., without losing significance. Besides, the greater amounts of rainfall at these stations have been used in calculating the averages for the altitude zones, magnifying, therefore, these averages so that the actual difference between the calculated quantity and the actually observed one appears really smaller than if the quantities from deforested and forest areas are compared.

Expressed in percentages of the height of precipitation, an increased rainfall is shown for several localities in very large quantities, which will allow considerable reductions for other influences without losing their significance for the main proposition.

Especially important appears the fact relating to two stations near the rain minimum, which also shows this influence of the forest.

Lastly, as a matter of interest, I may state that the water balance is drawn for the whole kingdom, which is of special value, because the political boundaries coincide with those of the upper Elbe watershed; therefore it is easy to determine how much of the yearly rainfall is removed by the natural water-courses. According to the calculations made for the various zones by addition, the total precipitation upon the area of 51,955.98 square kilometres (about 20,000 square miles) of the kingdom is found to be 35.398,-670,000 cubic metres, of which the Elbe carries about one-quarter, or ten cubic kilometres, to the sea. This figure represents a mean rainfall for the whole country of 681 millimetres, while the mean observation is 693 millimetres.

In conclusion, allow me to say that I believe neither of the methods employed will alone be sufficient to investigate such a complicated relation in its generality as that which they try to establish or refute. All of them, modified and provided with such safeguards as will exclude the many disturbing influences, will have to work together towards a solution of the question.

Mr. Gannett's Paper.

At its last meeting, the society was favored with a very interesting and important paper by Dr. Fernow, in which there was presented a *résumé* of certain investigations made in this country and

Europe, concerning the supposed influence of woodland upon precipitation.

While criticising the methods used in these investigations, Dr. Fernow did not, if I understood him right, give his own views upon the main question.

The question is, Does the presence of woodland influence rainfall, does its increase increase rainfall, and does its destruction reduce it? I know no theoretical grounds upon which an affirmative belief can be based.

While the question is an interesting one to science, it is also a particularly important economic one to this country. The future value of a large part of our arid region, and our policy in regard to it, depend upon the decision. If the presence of woodland increases rainfall to an economic extent, we should begin at once to plant trees all over our Western plains, and supply them with water until they in turn supply themselves and the adjacent land with moisture. If they do not increase the rainfall, then perhaps the land which is now being covered with woods can be more profitably used for wheat. Again: the welfare of much of the eastern United States, now well watered, may turn in the future upon the decision of this question. In some parts the forests are being cut away, and thereby the rainfall may be reduced to such an extent as to make the soil unproductive, in which case the timber-cutting should be stopped in time.

From this the economic point of view, it must be recognized that to be of any value, the influence of woodland upon rainfall must be considerable in amount. A minute influence is equivalent to none at all, so far as economic effect is concerned. If it should be found that woodlands induce only a trifling modification in rainfall, the solution of the question is substantially in the negative, viewed economically. In our examinations of records and other tests of the comparative amount of rainfall under differing conditions of forest-covering, we are, then, to look for changes of considerable magnitude. The variations in rainfall from year to year and from place to place are great, — so great as to mask, in a limited series, or in observations at a few stations only, any general change. It is, of course, understood that the difficulty in the way of detecting the general movements of rainfall lies in these temporary and local fluctuations, and it is apparent that to eliminate them it is necessary to use what Dr. Fernow aptly calls the wholesale method, to bring together into the investigation large numbers of observations, from many stations, scattered widely over the territory under examination. I cannot conceive any retail method that will yield a result worthy of any confidence, as is shown by the fact that it is very easy so to select stations and years of observation as to obtain any desired result.

Of the retail methods of investigation in use in Europe, cited by Mr. Fernow, that of pairs of stations, one situated within the forest, the other 100 metres outside it, seems to promise no result; first, because it is a retail method, and, second, because if the forest has any influence, it must, in order to be of any value, be felt more than 325 feet away from the margin of the forest. We cannot afford to cover the land with woods in order to increase the rainfall. We must have some land to cultivate. The conclusions from the observations in Bohemia, cited by Mr. Fernow, can only be misleading. To compute from the rainfall in the open valley, and from an estimate of the rate at which rainfall increases with elevation, the theoretical rainfall upon cleared mountain-sides, and then to conclude from the discrepancies between these results and the observed rainfall upon the timbered mountains that the forests have had a certain effect upon the rainfall, is a case of theory run riot.

I know of but two attempts to use the wholesale method, both of which were mentioned by Mr. Fernow, — that of Mr. Harrington and my own. Mr. Harrington's method consists in a comparison of two rainfall maps made from data of different dates, — the Blodget map, made in 1857; and the Denison map, made in 1844. The two maps are not strictly comparable, as the first purports to show areas of equal rainfall, while the last shows lines of equal rainfall. Nevertheless, the former may be made rudely comparable with the latter by means of certain assumptions regarding the relative positions of these lines and areas. Mr. Harrington's examination was confined to the supposed increase of rainfall on the plains. Finding that the isohyetal lines of 20, 25, and 30 inches were in some places slightly farther west on the Denison than on the Blodget map, he concluded that the rainfall has increased.

What is the value of this evidence, and, first, of what authority are the maps? Upon the Blodget map I find only five stations in the entire area of the plains, north of Texas; viz., Forts Riley, Leavenworth, Atkinson, Arbuckle, and Kearney. The only data in this area of nearly half a million square miles consists of the observations at these five stations. It may be safely said that the rainfall-curves in this area are at least 99 per cent hypothetical. They might as well be drawn a hundred miles on either side of the position assigned them by Mr. Blodget, without contradicting the observations. Their position is necessarily based almost entirely upon Mr. Blodget's judgment, and not in any appreciable degree upon observational data. The Denison map is better. The worst that can be said of it is that it is a popular map, made to sell. But the weakest link in a chain limits the strength of the chain, and the Blodget map is the weakest link in Mr. Harrington's chain of evidence. With it his conclusions must stand or fall, and, as has been shown, this link is most absurdly weak.

Let us look at the matter from another point of view. If Mr. Harrington's conclusions regarding the rainfall on the plains, drawn from a comparison of these two maps, are correct, similar conclusions regarding the rainfall of other parts of the country must likewise be correct, especially as the data upon which the map is based are elsewhere more abundant, and the maps correspondingly more reliable. Let us see what other changes are shown by the maps to have occurred. About Cape Hatteras the rainfall has apparently increased from 48 to over 70 inches; in southern Louisiana, from 45 to 60; in northern Florida, from 50 to 65; in the mountains of North Carolina, from 36 to 48; and so on. It is unnecessary to specify further changes, as there is scarcely any part of the country in which, if this method of reasoning be correct, great changes in rainfall have not occurred between 1857 and 1884.

The method employed in my investigation of this question, and the results obtained, are set forth in an article in *Science* for Jan. 6, 1888. The explanation there given seemed to me to be sufficiently clear for the average reader. It appears, however, that it admits of being misunderstood, and has been misunderstood by Mr. Fernow. I will therefore state it once more, and with greater fulness. The method used is a wholesale one. Certain areas in this country, of great extent, in which the changes in respect to forest-covering have, within recent years, been radical, were selected, and an examination was made of the rainfall measurements in these areas during the time of foresting or deforesting, in the hope, not of obtaining a quantitative expression for the influence of forests, but of learning whether they have appreciable influence. One of the areas selected was the prairie region, where it is well known that during the past fifty years the wooded areas have greatly increased, — so greatly as to change the whole aspect of the country. This increase of woodland has been a progressive one, going on gradually year after year. Now, if increase of woodland increases the rainfall, it follows necessarily, that, barring its sporadic fluctuations, the rainfall also has increased progressively in this region. The following, then, is the proposition to be proved or disproved by the rainfall records: that the rainfall has increased, and that progressively, in the prairie region during the past fifty years, as foresting has gone on. Within this region I had access to the records of twenty-four stations scattered widely over the area, each station having a series of records of considerable length, ranging from ten to forty years. These series are scattered over the past fifty years in an irregular manner, and no attention was paid to the particular years which each series embraces, as it is not believed that it is a matter of any importance. The series from each station was cut in halves, and each half added, giving the total rainfall of each half. Now, were there no sporadic fluctuations, — in other words, were the rainfall regular in amount, — the comparison between the sums of the halves of each series would be sufficient to base a conclusion upon. If the rainfall had increased, the earlier half series would be less than the later half. As a matter of fact, however, these individual results are very discordant, owing to the irregularities of rainfall; and it is necessary,

in order to get rid of these irregularities, to get together a larger number of observations. This is done by simply adding together all the first halves and all the second halves: that is, in this case, I have added columns, etc. As I understand it, exception is taken to this operation, as bringing together quantities which are not homogeneous. Suppose that, instead of adding up directly each half of a series, the mean rainfall at a station is obtained from the whole series. Now, if the proposition as above stated be correct, this mean rainfall is, barring irregular fluctuations, the rainfall of the middle year of the series. Let the residuals be taken. Is there any impropriety in adding up the residuals, not only in each half-series in one sum, but those of all the half-series, for comparison of the sums of the two half-series?

Or, to put it in mathematical form, let R equal the mean rainfall of a series, which is equal to the rainfall of the middle year, r the rainfall at any time, t the interval in years before or after the middle year (plus when after, and minus when before), x equal the rate at which the rainfall is supposed to increase, which may be assumed as constant over the area, as it is a qualitative rather than a quantitative result which is sought. We desire to learn whether x has any considerable value. Then

$$r = R \pm tx, \text{ and } x = \frac{r - R}{\pm t};$$

and, for a single series,

$$x = \frac{r_1}{t_1} + \frac{r_2}{t_2} + \frac{r_n}{t_n} - \frac{r^1}{t^1} - \frac{r^2}{t^2} - \frac{r^n}{t^n},$$

the mean rainfall R being eliminated: x being the same over the entire area, and the mean rainfall being eliminated, the above equation applies to all series, and they may be properly combined for the purpose of obtaining the value of x, and

$$x = \left[\frac{r_n}{t_n}\right] - \left[\frac{r^n}{t^n}\right].$$

As has been stated, this method was used to test the above proposition, in the prairie region. Twenty-four stations were used, and the observations of 428 years were used in evidence. The result showed that there was a trifling amount *more* rain in the earlier than in the latter half of the series. In short, it showed that the rainfall had not increased.

It was applied in Ohio, which from a forested area has become with settlement mainly a deforested area. Under the terms of the proposition, the rainfall should have diminished, but the amount of the diminution is trifling, being but .21 of an inch per year. To this result twelve stations, with 294 years of observation, contributed.

Southern New England, comprising some 20,000 square miles, was originally a densely forested region. With the progress of settlement it was almost entirely cleared. In recent years, say since 1860, a reverse movement has been going on. The competition of Western farms and cheap transportation is driving New England farmers to other vocations, or is forcing them to move to other parts of the country. Thus the farms are being abandoned, and are growing up to woods. To-day Massachusetts contains 52 per cent of woodland, and Rhode Island even more. Southern New England, then, presents two phases of change for investigation. During the earlier period, with the cutting-away of forests, the rainfall should have diminished, while during the past twenty-eight years it should have increased. During the first period there were used in the investigation eighteen stations, with 400 years of observation. The examination showed that the rainfall had *increased* while deforesting was going on.

In the second period fourteen stations were used and 200 years of observations. The examination showed no change whatever.

This investigation has convinced me that forests exercise no influence whatever upon rainfall. I wish to state this plainly, as it was suggested at the last meeting that I had some doubts concerning the results obtained. I regret that any thing in my paper should be capable of such a construction, as it was certainly as far as possible from my thoughts.

I am aware that this conclusion is at variance with the popular idea, and that a popular idea is not a thing to be disregarded, as there is usually some reason for its existence. We find woodland and a heavy rainfall generally co-existing. In almost all places enjoying a heavy rainfall, the land is covered with forests, unless they have been removed by man. It may be that in this case an effect has been mistaken for a cause, or rather, since it is universally recognized that rainfall produces forests, the converse has been incorrectly assumed to be also true.

Although forests have no influence upon precipitation, yet they do exert a certain economic influence. Without increasing rainfall, they, in common with other forms of vegetation, economize that which falls, retaining it somewhat as a reservoir, and preventing its rapid descent into the streams. In this way, too, forests tend to reduce the magnitude of floods and to regulate the flow of rivers, thus preventing disaster and improving navigation. This retention of the rainfall is, however, accompanied by a rapid evaporation from the leaf surfaces of the forest, whereby a considerable proportion of the rainfall returns to the atmosphere without reaching the earth. On this account it is urged, and I think with reason, that in our arid region, which is dependent for irrigation upon its streams, it is advisable to cut away as rapidly as possible all the forests, especially upon the mountains, where most of the rain falls, in order that as much of the precipitation as possible may be collected in the streams. This will cause, not a decrease in the annual flow of the streams, as commonly supposed, but an increase, coupled with a greater concentration of the flow in the spring months, and result in rendering fertile a greater area of the arid region. It may be added that the forests in the arid region are thus disappearing with commendable rapidity.

There is no question but that forests reduce the extremes of temperature in their immediate neighborhood. They also serve mechanically as windbreaks, diminishing the force of air-currents. In these and perhaps other ways they serve a useful purpose.

But with all this in mind, is it worth while to go on planting trees for their climatic effects? It seems to me, that, apart from the uselessness of it, nature is planting trees at an infinitely more rapid rate than man. For every tree planted under the timber-culture act, or on Arbor Day, a thousand spring up of their own accord. Every deserted farm east of the plains grows up to forest. Half of southern New England is to-day wooded, and the proportion is increasing every year, and yet in Massachusetts they have every year an Arbor Day, when the farmers turn out and solemnly plant a tree apiece.

MENTAL SCIENCE.

The Psychology of Deception.[1]

THE deceptive character of the evidence of the senses has become attributed to them because of the failure to recognize that we seldom have to do with a simple sensation. What deceives is not the information of the sense, but the wrong interpretation of this information by the mind. Such interpretation need not be conscious, and often is not so. The familiar experience of raising a pitcher of water, usually well filled but upon the present occasion empty, and finding it dart upwards in our hands, is a case in point; for it shows that we estimate the amount of force necessary to raise the pitcher, but only become conscious of this inference when it happens to lead us astray. The phenomena of the stereoscope abound in illustrations of such unconscious reasonings. One of the simplest types of deceptions arises when such an inference, owing to an unusual disposition of external circumstances, leads to a conclusion that better evidence shows to be false. A ball held between two crossed fingers seems to be double, because under ordinary occasions an impression on the right side of one finger and on the left side of its neighbor (to the left) could only be brought about by the simultaneous contact of two objects. Everywhere, then, we interpret the unfamiliar by the familiar, the unknown by the known: illusion arises when the objective conditions change their character, and real deception occurs when this change is not recognized, when no better evidence is present to antagonize the false inference. The child who regards a spoon half immersed in water as really bent,

[1] See an article with this title by Joseph Jastrow, Ph.D., in the *Popular Science Monthly*, December, 1888.

the moon high up in the sky as really smaller than when near the horizon, presents a case of such deception.

No better instances of deceptions depending upon unusual objective arrangements can be found than the ordinary conjuring tricks. Here deception depends solely upon an ignorance of the devices employed. When ink is turned into water, when two half-dollars are rolled into one, when a box in which you have just placed an article is opened and found to be empty, or when a card suddenly changes from one face to another, deception takes place when the spectator is ignorant that a chemical can change the color of liquids, that one half-dollar is hollow and allows the other to fit into it, that the box has a double bottom, and the card a flap, that, falling down, shows another aspect. These objective arrangements are often much more complex, and the conditions that ordinarily lead to correct inferences are imitated with remarkable ingenuity. The accepted rule of conjuring, to always first actually do that which afterwards you desire the audience to believe you have done, shows keen insight into the workings of the mind. When coins are caught in the air and thrown into a hat, a few are really thrown in ; the others palmed in the hand holding the hat, and allowed to fall when the other hand makes the appropriate motions.

Leaving the objective conditions of deception, and turning to the subjective, the psychological interest is deepened. If our condition departs from the normal, however slightly, and we fail to recognize the variation, illusion is apt to arise. The phenomena of contrast and fatigue are simple cases in point. Fatigue the eye for red, and it sees white light as green. Plunge the hand from hot water into luke-warm water, and it will feel the latter as cold. When a disturbed mental judgment is present to misinterpret such unusual sensations, illusions of a very serious type may arise. But even within the limits of normal judging powers, the emotions, the interest, expectation, can alter the nature of a sense impression. In all perception two factors contribute to the result,— the attitude of the percipient, and the nature of the object perceived. When the naturalist observes what the stroller overlooks, or the sailor detects a distant sail when the landsman's eye sees nothing, it is because the former knows what to expect. When expecting a friend, any indistinct noise is converted into the rumbling of carriage-wheels, as the mother hears in every sound the cry of her sick child. The conjurer, taking advantage of this, creates an interest in some insignificant detail, and draws the attention away from the real trick. His wand, his motions. his talk, are all intended to give him a favorable moment for doing the real trick before the unobserving eyes of the spectators. When he counts 'one, two, three,' centring all the emphasis upon 'three,' and thus focusing the attention of the audience upon that instant, he does the real transformation at the unattended 'one' or 'two.' The conjurer's art is largely composed of devices for misleading the attention: a trick is successful according to the setting that the performer can give to it.

In one point, however, the conjurer's performance fails to illustrate the psychology of deception. The attitude of the spectator is too definite. He knows that he is being deceived and has nothing at stake. Quite different was it when such a performance carried with it a belief in the magical and mystical, when the spectator believed himself in the presence of powers that could be turned against him and his welfare. The best parallel to this attitude in modern times is seen in the physical phenomena of Spiritualism. The medium performs to sitters in doubt as to the true explanation of the phenomena, or more or less ready to credit every thing to the supernatural. Such an expectation can see a miracle in the simplest conjuring tricks ; and more than once have professional conjurers been declared to be mediums in spite of all protests from themselves. The general rule at the séance, where the emotions are strung to the highest pitch, and the judging faculties labor under the worst conditions, is that the spectators see whatever they are interested in seeing. The same form is recognized by various spectators as the spiritual counterparts of totally dissimilar persons. Only let the form be vague, the light dim, the emotions at a strain, and what is lacking in the object will be supplied by the imagination of the spectator. In the same phenomena each finds proof of his own pet beliefs, until the refusal to mistrust the evidences of an excited consciousness leads to actual mental disorder. The records of the witchcraft delusion show the same result: the facts are seen in the light of the prevailing theory. "With the doctrines of modern Spiritualism to be supported, the number of mediums and manifestations will be correspondingly abundant. Create a belief in the theory, and the facts will create themselves."

To all this must be added the enormous influence of mental contagion. Wherever a subjective influence contributes to the resulting deception, contagion plays a part, — fear, panic, fanaticism, superstition, all flourish in crowds. The witchcraft delusion and the spiritualistic movement show to what dimensions psychic beliefs can attain when fanned by the flames of emotional enthusiasm. If, in addition to all this in which self-deception plays the leading *rôle*, we add the variety of illusions carried on by conscious fraud, we may perhaps appreciate the enormity of error through which civilization has made its way. Such errors are destroyed, not by logical disproof, but by rendering unsuitable the soil upon which they flourish.

THE ALLEGED EVOLUTION OF COLOR SENSITIVITY.[1] — To test the theory frequently met with, that in the thirty centuries of civilization the human retina has developed a gradually increasing color perception, — the homeric man seeing chiefly the red end of the spectrum, and blue coming in much later, — M. G. Pouchet compared the proportion of color epithets in types of the literature of various ages. He selected (1) a very recent work of M. Guy de Maupassant on water, (2) 'Paul et Virginie,' as typical of the beginning of the century, (3) Books I. and VII. of 'Telemaque' for the same reason, (4) Chapters XIV. to XXII. of the second book of 'Pantagruel,' taken at random from 'Rabelais,' and (5) a short romance, 'l'Ane,' attributed to Lucian. (1) gave the following number of color appellations: white, 21 times; black, 14; gray, 3; brown, 4; all kinds of reds, 23 (including pure red — 15); yellow, 5; green, 6; varieties of blue, 17 (in which pure blue occurs 12 times); and violet, 3 times; in all, 96 terms. Taking only the primary colors, we have red, 26; blue, 17; green, 6; yellow, 5; and violet, 3. (2), though more extended a work than (1), gave the following: white, 13; black, 15; gray, 1; varieties of red, 11; varieties of blue, 7; of green, 8; yellow, 1: or red, 11; green, 8; blue, 7; yellow, 1. (3) gives black, 2; white, 2; red and shades, 4; green, 2. One might add golden, 2, and reddening, 2; and would thus have red, 6; yellow, 2; green, 2. (4) gives black, 1; white, 3; red and varieties, 7; green, 2; blue, 1. (5) gives but one name, red. The result is that writers show a marked tendency to describe red things, and this tendency holds good for all times. If we survey the ordinary color impressions to which the retina is exposed, we find, first, a general brightness involving all colors, — the blue of the sky, the reds of sunrise and sunset, the whites and grays of clouds; words expressive of these abound. Considering next colors in which whiteness does not enter, we find that a true violet is extremely rare in nature. Blue, too, is little fitted to be physiologically conspicuous as it presents itself in nature. Yellow is more extended, especially on flowers, but it loses its individuality in a general whiteness. There remain green and red. The reason why red has acquired so striking an effect is, that, owing to the preponderance of green, the red is conspicuous by contrast. Again, red, as the color of blood, as the symbol of fire, as the color first and most sought after in dyes, would soon acquire a moral and intellectual prominence that would lead to its frequent mention. The proper conclusion, then, is not that our ancestors were unable to see blue and its allied shades, but that they followed the natural tendency to describe what was prominent, and this coincides with the red.

THE MENTAL POWERS OF THE APE. — According to a recent letter to the London *Times*, Mr. Romanes has succeeded in teaching an ape to count; not merely to detect differences of number, but to associate different groups of sensations with vocal sounds. Fearing that if too complex the experiment would entirely fail, the counting was attempted only up to five. By refusing all but the number of straws asked for, and rewarding the ape for a correct performance, the creature was taught to give at command one, two, three, four, or five straws. His method is to take the straws one by one into his mouth, until one less than the required number have been collected; then, taking up an additional straw, he hands it over, together with those in his mouth, — certainly a remarkable performance.

[1] *Revue Scientifique*, Oct. 13.

ETHNOLOGY.

A Mexican Feather Ornament.

THE trustees of the Peabody Museum of Cambridge have decided to issue in a separate form such special papers as have heretofore been published in connection with the annual reports. The first number of this new publication, which will have the title *Archæological and Ethnological Papers of the Peabody Museum*, has just been issued, and is of great interest. Mrs. Zelia Nuttall discusses the meaning of the widely known Mexican feather ornament in the Vienna Museum of Natural History, which dates back to the time of Charles V. The modest title 'Standard, or Head-Dress,' which she has given to her study, covers, however, an historical investigation of the greatest value. Starting from a consideration of the interesting specimen, she gives conclusive proof that it was one of the head-dresses used by Mexican war-chiefs. In this investigation the authoress for the first time applies her discovery of complementary signs in the Mexican graphic system, which was announced two years ago at the Buffalo meeting of the American Association, to deciphering a certain iconograph; and in an appendix she sets forth more fully the essential features of these signs. A hieroglyph may represent various sound-combinations, as the object represented is liable to be designated by synonymous names. In order to show which name was meant, complementary signs were used, the phonetic value of which determined which word was meant. An arm and hand, for instance, might express *maitl* ('arm') as well as *acolli* ('shoulder'). If above the arm the conventional sign for water (*atl*) is painted, yielding in composition the phonetic value *a*, which is also the first syllable of the word *acolli*, this complementary sign indicates that the latter word is meant. This discovery of Mrs. Nuttall promises to be a great help in the decipherment of Mexican texts. The question as to the real significance of the feather ornament is decided by a thorough investigation of the use of banners and head-dresses in ancient Mexico. The authoress's final conclusions are briefly summed up as follows: The testimony of native Mexican paintings and sculpture, and of early Spanish records, taken into consideration with the evidence furnished by its structure, and also by the appellation bestowed upon it in the Inventory of 1596, in which the first record of the specimen is found, proves it to be a head-dress. Manufactured with the utmost care, of materials most highly esteemed by the Mexicans, uniting the attribute and emblematic color of Huitzilopochotli, fashioned in a shape exclusively used by the hero-god's living representative, the high-priest and war-chief, this head-dress could have been appropriately owned and disposed of by Montezuma alone at the time of the Conquest, from which period it assuredly dates.

TEXTILE PATTERNS OF ANCIENT PERU. — Dr. Alphons Stübel, who, in company with W. Reiss, spent five years in travels of discovery through Peru and other parts of South America, and edited conjointly with him the pictorial work, 'Das Todtenfeld von Ancon' (Berlin, 1880–87), in a volume published at the celebration of the twenty-fifth anniversary of the Dresden Geographical Society, treats on "textile patterns of ancient Peru compared with analogous ornaments of classic art." The various ornaments, consisting of squares, trapezoids, lozenges, circles, etc., give origin to more complicated ornaments by a combination of the same geometrical figures whenever one of these is shoved on to another of the same description by sliding it on below, on the sides, or on any point where both can combine. Stübel's ideas are very original and ingenious, but whether the inventors of these ornaments really obtained the ideas for their multiple patterns in this way is rather to be doubted. The pamphlet is illustrated by a large number of designs, and fully deserves notice.

THE MIGRATIONS OF THE BANTU. — Mr. H. H. Johnson, the well-known African explorer, advances, in a recent number of the Proceedings of the Royal Geographical Society, a suggestive theory of the origin and migrations of the Bantu and their northern neighbors. He believes that their common home was in the region between the Shari and Welle-Ubangi. From this centre, he thinks, emigrants had constantly been starting to the west, and had carried with them their languages, which have given rise to most of the languages in western Africa between the Gambia and the Niger. But there still remained in this district north of the Kongo, east of the west coast watershed, south of Lake Chad, and west of the western affluents of the Nile, two flourishing and nearly allied tribes, whom he calls the Bantu and Semi-Bantu. Later on, both peoples were driven from their homes. The Semi-Bantu proceeded due west towards the Niger, and the Bantu turned to the south and south-east. The Semi-Bantu greatly discarded and wore away the grammatical structure inherited from its mother, and which its Bantu sister developed and perfected, but retained in a great measure its primal stock of word-roots. Mr. Johnson continues, "These tongues, while retaining many roots in common with the Bantu, have a grammatical structure which lacks all, or nearly all, Bantu features. The resemblance in vocabulary to the Bantu increases as you proceed eastward, but is not to be explained by the theory of 'loan-words,' because the similarity of the word-roots strikes too deeply into the language-system." We would be more inclined to conclude from this statement that the 'Semi-Bantu' are mixed languages. "The primitive Bantu tribe," Mr. Johnson continues, "moved away from its original home in a south and south-easterly direction, and probably located itself for some time in the district lying between the Welle, the Kongo, and the Muta-Nzige and Albert Nyanza Lakes. Here, no doubt, it settled down for a while, and throve and multiplied; and here probably it received the ox, sheep, goat, pig, and domestic fowl from tribes to the north, to whom they had permeated from Egypt. Rapid increase and its consequent troubles caused the primal Bantu people to again split up and its sections to part company, and the great Bantu invasion and occupation of the southern half of Africa began to take place. Except the feeble, dwarfish races of Akka or Hottentot and Bushmen, there seem to have been few inhabitants to dispute southern Africa with the Bantu, and from their centre of activity they sent out streams of emigrants westward along the Welle and the Kongo, eastward to the Nile lakes and the Zanzibar coast, and southward to Damaraland and Natal." Although this detailed theory seems to be constructed on rather slight evidence, it is an interesting attempt at explaining the complicated ethnological phenomena of Africa.

ELECTRICAL SCIENCE.

Electric Street-Railways.

THE next three months will determine whether there will be rapid advance in the equipment of electric street-railways, or whether they will have a decided set-back. There have been roads equipped in New England during the summer that will have a severe test this winter, and there are few places where the equipment will not have to do heavier work than ever before.

At the beginning of the year the Sprague Electric Railroad and Motor Company did not have a car running; the Thomson-Houston Company — then the Van Depoele Company — had half a dozen roads in operation; the Daft Company, about as many. To-day the Sprague Company has thirty roads completed or in course of construction; the Thomson-Houston Company, about as many; the Daft Company, perhaps a dozen; with a number of other systems represented by single roads in different localities.

There have, too, been radical changes in the methods that were used only a short time ago. The Thomson-Houston truck, with the motor pivoted on the axle and gearing direct to it, is a very different affair from the Van Depoele motor placed in a compartment in the car, driving the wheel-axle by a chain belt. The Sprague Company have also gained something from experience; and the last type of motor and gear with the single magnetic circuit, the admirably simple method of reducing the speed, and with the new brush for the commutator, is a marked improvement on the type they have been building.

It is significant, that, with a few exceptions, the method used to convey the current to the car is by an overhead wire. The question of street-car propulsion is mainly one of economy, and it is but natural that horses should be first displaced where the most economical electrical system is allowable. But it will be seen, that, if we are to retain our prejudices against the overhead wires in our city streets, the real problem of displacing horses in city

tramways has not been solved, nor is it much nearer solution than it was a year ago. The ideal system for such work is undoubtedly the storage-battery system, and the experiments that have been made in that direction are few. In Philadelphia a partial test of storage-batteries was made, with the result — as stated before the Street Railway Convention a month ago — that the cost of running a car was nine dollars per day, — about that of horses. In New York the cars on the Fourth Avenue Road are being slowly equipped, but it is too early to obtain even approximate figures as to the cost. A storage-car was run for a few months in Baltimore, and another in Rochester, but nothing has been heard of them for some time.

So that, although a number of roads have been equipped with electricity, yet the work has been in the direction of suburban tramways, and the question of city tramways remains still unsolved. But the important question now is, what will be the effect of snow and sleet on the overhead structures, and on the possibility of propelling the cars? And according as the reply is favorable or not, will the work of next year be satisfactory or otherwise. If there are no hitches other than any system would be subject to, then it is easy to predict that next year the companies engaged in electric railroading will get as many roads to equip as their capacity will allow, for on the question of economy of operation there is no doubt.

It should be the aim, then, of the electric-motor companies to supply every possible means of clearing the tracks of snow and ice. In Boston the Sprague people have constructed a special clearing car with an abundance of power, and with brushes worked by electric motors, for clearing the track, and it is fair to suppose that such an arrangement will be more efficient than a team of horses. It is probable that both this company and others have equipped all of their roads with some such construction-car. If they have not, they will lose by it, for this winter will test electric tramways; and the company that best stands the test will have the most work next year.

THE WESTINGHOUSE COMPANY'S EXTENSIONS. — The growth of the Westinghouse Electric Company in the last two years is one of the remarkable features of the rapid extension of the applications of electricity now taking place. Two years ago the alternating system of electric distribution was practically unknown in this country: several successful installations were in operation in England and on the continent, but it had not been taken up here. The Westinghouse Company purchased the patents of Goulard and Gibbs, and undertook the exploitation of the system with so much energy and success, that to-day they have over three hundred thousand lights in operation. At first they had no fundamental patents on incandescent lamps, under which to operate; but a combination with the Sawyer-Mann interests gave them the protection of the patents granted to Sawyer and Mann, and in the last few weeks they have absorbed that company. Their latest move has been the purchase of the control of the Waterhouse Electric Company, whose system of arc-lighting has many points of merit. Some time ago the Tesla patents for alternating-current electro-motors were acquired, and now the Westinghouse Company advertises that they are ready to supply motors for their alternating circuits. It would seem as though this company was gathering its energies for the conflict between alternating currents with converters and continuous currents with secondary batteries, — a conflict that is already at hand. They have very wisely secured control of apparatus that will enable them to use their stations to the fullest capacity possible. They can supply arc lamps, incandescent lamps, and motors from the same station, and the latter will partly compensate for the advantages that secondary batteries offer. It is not probable, however, that in the lighting of crowded city districts they will be able to successfully compete with a direct system of distribution, especially if electric-light wires are ordered under ground, and if storage-batteries are slightly improved. But the field for the alternating system is wide enough to fully occupy the energies of even the Westinghouse Company.

THE ELECTRIC LAUNCH 'VISCOUNTESS BURY.' — The London *Electrical Review* describes, in a recent issue, this launch, — the largest, with one exception, in the world. She will carry eighty passengers comfortably. Her dimensions are 65½ feet long by 10 feet beam, with a draught of 22 inches and a displacement of 22 tons. Her rudder is specially designed with the object of clearing weeds and obstructions. The steering-wheel is forward: adjoining it is an indicator communicating with the electrician in charge of the switches controlling the electrical power. The electrical energy is stored in two hundred of the Electric Power Storage Company's accumulators of the 1888 type, each of which has a storage capacity of 145 ampère hours, with a discharge-rate up to 50 ampères. These cells are arranged one hundred on each side under the seats. The space occupied by them is lined with lead, with small drains leading off, so in case of accident there would be no damage from the acid. It is calculated that the stored energy will propel the vessel for ten hours at six miles an hour. Twin propellers are used, each driven directly by a 7½-horse power Immich motor, making one thousand revolutions per minute. The switches are fixed so that either motor can be worked independently of the other; or they can be driven at half speed or astern. All of the machinery is beneath the flooring, leaving a clear space fore and aft for the passengers.

THE DIRECT UTILIZATION OF THE SUN'S ENERGY. — Many plans have been proposed for the direct utilization of the sun's energy, — Ericsson's heat-engine supplied by solar radiations; the plan of MM. Conova, Piffre, and Mouchot, who proposed to concentrate the sun's rays on a mass of water, which would be turned into steam; with a number of others, none of which have even reached the stage of successful experiment. Mr. Edward Weston proposes, and has recently patented, the idea of using a thermopile, which is to be placed in the focus of a mirror or lens, and which is to be used to charge a storage-battery, from which the energy is finally to be drawn. An electro-magnet in the circuit is so arranged as to cut out the pile when its electro-motive force falls below that of the battery. When we consider the very low efficiency of thermopiles, — not over three or four per cent, — it would appear doubtful whether the plan will ever be more than an interesting suggestion.

BOOK-REVIEWS.

Fifteenth Annual Report of the Secretary of the State Board of Health, Michigan, for the Fiscal Year ending June 30, 1887. Lansing, State. 8°.

IN addition to the statistics and routine reports usually found in official health reports, this volume contains a number of exceedingly valuable contributions to sanitary science. The most important of them is that which describes the investigations conducted in the State Laboratory of Hygiene, under the direction of Prof. V. C. Vaughan. These include experimental studies on the causation of typhoid-fever, poisoning from tyrotoxicon, and an exposure of the stenocarpine fraud. At the time this exposure was made we called the attention of our readers to it. It will be remembered that the announcement of the discovery of a new local anæsthetic was made through the medical journals, to which the name of 'stenocarpine' was given. F. G. Novy, M.St., instructor of hygiene in the State Laboratory, analyzed the drug, and found it to be a mixture of cocaine and atropine. Since the publication of his analysis, nothing more has been heard of stenocarpine, and we are informed that it has been withdrawn from the market.

The cases of poisoning from tyrotoxicon which were investigated were those which occurred at Milan, Mich., in September, 1887. Four persons in one family were poisoned; and of these, three died. Professor Vaughan reports that the sickness was distinctly traceable to milk, in which tyrotoxicon had developed. The milk was kept in a buttery, the floor-boards of which had rotted, so that a second layer of boards was necessary. Between these two floors a great mass of moist, decomposing matter was found, the accumulation of years. When the floor was taken up, a nauseating odor was perceived, sufficient to cause vomiting in one of the persons engaged in the examination.

The experimental studies on the causation of typhoid-fever were made by Professor Vaughan and Mr. Novy, and had special reference to an outbreak at Iron Mountain, Mich., in October, 1887. Attention seemed to be directed to the drinking-water used by the

families in which the disease appeared, and this was accordingly examined. Believing that the ordinary analysis, which consists in the determination of free and albuminoid ammonia, chlorine, etc., would be entirely inadequate, it was decided to inoculate sterilized meat preparations and sterilized milk with the suspected water, and to keep this material at or near the temperature of the human body for varying periods of time, and ascertain whether or not there would be any poisons developed by the bacteria, which were suspected of being in the water. This method was followed, and resulted in demonstrating that the water contained a ptomaine which produced poisonous symptoms; and a cultivation of the micro-organisms in the water upon potato, together with certain physiological experiments, showed that the water contained typhoid bacilli. It has been shown that the fever was brought to Iron Mountain by a man from a railroad construction camp. In commenting on this outbreak, the investigators state that it is well known that typhoid-fever invariably follows dry seasons, and is coincident with low water in wells. There are, on an average, about one thousand deaths and ten thousand cases of sickness from this disease annually in Michigan. These figures can be greatly reduced if people will cease polluting the soil about their houses with slops, garbage, cesspools, and privy-vaults, and will see to it that their drinking-water is pure beyond all question. When there is any doubt, the water should be boiled; but it should be remembered, that, while the typhoid germ most frequently finds its way into the body with the drinking-water, it may be taken in with any food, and even with the air. When a case of typhoid-fever occurs, all discharges should be thoroughly disinfected; and the earth, water, and air about our homes must be pure, if we escape this disease altogether.

The causation of cold-weather diseases is discussed in the report by Dr. Henry B. Baker, the efficient secretary of the board. Although it is a recognized fact that many of the communicable diseases are most prevalent at certain seasons of the year, yet the extent to which their prevalence is controlled by meteorological conditions has not been thoroughly shown by statisticians. This Dr. Baker does by means of tables and diagrams, which exhibit the close relations which diphtheria, small-pox, and scarlet-fever bear to atmospheric temperature. He finds that diphtheria is most frequent in the autumn and winter, accompanying somewhat, in its rise and fall by seasons and by months, the fall and rise of the temperature, and the rise and fall of the velocity of the wind. Small-pox bears a quantitative relation to the atmospheric temperature, rising after the temperature falls, and falling after the temperature rises. Scarlet-fever falls after the temperature rises in the spring, and rises after the temperature falls in the autumn, the sickness changes averaging about one month later than the temperature changes.

The whole report is a valuable one, and reflects great credit on the State board and its officers.

Livy. Book XXII. Ed. by M. T. TATHAM. Oxford, Clarendon Pr. 16°. (New York, Macmillan, 60 cents.)

The Second Book of Xenophon's Anabasis. Ed. by. C. S. JERRAM. Oxford, Clarendon Pr. 16°. (New York, Macmillan, 40 cents.)

Cæsar's Gallic War. Books I. and II. Ed. by C. E. MOBERLY. Oxford, Clarendon Pr. 16°. (New York, Macmillan, 50 cents.)

THREE volumes of this useful series have reached us. The twenty-second book of 'Livy' has been edited by M. T. Tatham. The text is preceded by a brief historical introduction and by a chronological table of the events described in the book. In an excursus the peculiarities of Livy's Latin are dwelt upon; and in the second part, which contains notes to the single chapters, difficult passages are explained. A good sketch-map of the western Mediterranean, on which Hannibal's march from Carthago Nova to Italy is sketched, accompanies the volume. The arrangement of C. S. Jerram's second book of the 'Anabasis' is made on the same plan, the selected book being made complete in itself, without presupposing a knowledge of the general contents of the 'Anabasis.' A sketch of the narrative down to the second book is given in an introduction. This book is also accompanied by a sketch-map showing the march of the ten thousand. Rev. Charles E. Moberly's edition of the first and second books of the 'Gallic War' is illustrated by numerous maps and diagrams. Besides the historical introduction and notes, and hints on the mode of translating Cæsar, it contains an appendix on the Roman military system. The books are printed in very clear type, — an important consideration for school-books, and will be found very useful by the teacher.

A Latin Prose Primer. By J. Y. SARGENT. Oxford, Clarendon Pr. 16°. (New York, Macmillan, 60 cents.)

An Introduction to Latin Syntax. By W. S. GIBSON. Oxford, Clarendon Pr. 16°. (New York, Macmillan, 50 cents.)

THE 'Latin Prose Primer' is intended to be used as a companion to Mr. Sargent's 'Easy Passages for Translation into Latin.' It is designed for the use of beginners. In a number of preliminary exercises, which consist of detached sentences, the pupil is made familiar with the various forms of Latin syntax. The second part consists of aids and explanations for the translation of a part of the 'Easy Passages.' Vocabularies, grammatical notes, and arrangement of the pieces so as to suit the Latin syntax, are given. In an introduction the principal difficulties to obtaining a good Latin style are treated at some length. Gibson's 'Introduction to Latin Syntax' will be found a very handy and useful book. The author does not give a mere collection of rules, but collections of sentences, from which the pupil has to find the rule by induction. Exercises are added to test the pupil's power of applying the rule which has just been arrived at. Separate vocabularies are given for the various parts of speech, the pupils being thus obliged to think before looking out a word, and one of the great disadvantages of dictionaries being thus overcome.

Microscopical Physiography of the Rock-Making Minerals. By H. ROSENBUSCH. Tr. by Joseph P. Iddings. New York, Wiley. 8°. $5.

THE translator of H. Rosenbusch's well-known 'Mikroskopische Physiographie der petrographisch wichtigen Mineralien' has endeavored to present this valuable book in such shape as to be best adapted to the use of colleges and schools. Therefore much of the interesting contents of the original have been omitted, which the advanced student will miss with regret; but the translator has shown good judgment in abridging; and the English edition, as it stands, is a fair general compendium of the subject. Most of the historical portions, which form so interesting a part of the original, have been omitted, as well as the elaborate treatment of the optical anomalies of certain minerals, and many notes on European localities, while a number of notes on American occurrences have been inserted. The book is a translation of the German edition of 1885, and we miss with regret the color-plate of the original, and descriptions of the newest improvements in microscopes. The prefaces to the first and second editions have been reprinted in German. Twenty-six instructive plates of photomicrographs, which formed so prominent a feature of the second edition, have been reproduced here. The translation has been made carefully, and the book, in its English form, will be a useful introduction to the study of the subject, although the advanced student will have to fall back upon the original.

The Ear and its Diseases. By SAMUEL SEXTON, M.D. New York, William Wood & Co. 8°.

IN many respects this work of Dr. Sexton's is unique. It is a wide departure from the beaten path, and contains a large amount of material which has never before, so far as we know, been treated in any one book, and much of it has never before been treated in a thorough manner; the discussions having been confined to medical and other scientific journals. Without attempting to mention all these peculiarities, we would nevertheless refer to some of the most prominent: viz., the influence in producing disease of the ear, of decaying teeth and sea-bathing; wounds and injuries of the ear occurring in warfare and civil life; rupture of the drum-head from boxing the ears, and its medico-legal aspect; concussion from the blast of great guns and explosives; noises in the ears, and their connection with insane hallucinations and delusions; the effects of false hearing on singers, actors, lecturers, and musicians; the classification and education of school-children with defective hearing; the effect of

high atmospheric pressure on the ear in tunnels, caissons, and in diving; and the subject of pension claims of soldiers, sailors, and marines on account of disability from deafness. Dr. Sexton has enjoyed remarkable opportunities for observing diseases of the ear, sixty thousand cases having come under his charge during the past twenty years, and is therefore entitled to speak with authority on all subjects connected with this important organ.

The author first treats of the anatomy and physiology of the auditory apparatus. He regards the theory of audition as set forth by Helmholtz as faulty, and accepts as the true explanation of the process the views of Professor Rutherford, announced by him in a lecture delivered before the British Association, and published in the *Lancet*, Jan. 1, 1887. Rutherford's theory is called by him the 'telephone theory of the sense of hearing,' for the reason that the processes in the two instances are so much alike, and a knowledge of the manner in which the telephone acts helps to explain the function of audition.

We have already had occasion in *Science* to refer to Dr. Sexton's views of the injurious effects of sea-bathing on the ear. Bathers in the surf are liable, when off their guard, to be struck by the waves upon the ear with much violence, especially in boisterous weather at full tide. Cold salt water may thus enter the external auditory canal with sufficient momentum to rupture the drum-head in persons having a large, freely open canal. Swimming or floating upon the back exposes one to the same dangers. There have been 273 patients under Dr. Sexton's treatment for aural disease caused by salt-water bathing, of whom 243 were males, and 30 females. Injury to the ear sometimes follows fresh-water bathing; and in Russian or Turkish baths there is also danger, the bather being at this time extremely susceptible to cold, and consequent catarrh of the upper air-passages.

The author has observed 51 cases of injury to the ear by blows of the open hand or fist, and 16 in which disease was attributable to missiles of various kinds, five being snow-balls.

One of the most interesting portions of the work before us is that which treats of injuries produced by long-continued musketry-fire, by the concussion from the blast of fire-arms and explosives, and by the impact of steam-whistles, metal-hammering, and other intense sounds. A large number of cases are described in detail illustrative of these injuries, many of them having occurred during the war of the Rebellion.

Defective school hygiene Dr. Sexton regards as one of the causes of ear-disease. Much has been written of the ills that arise from breathing foul gas and dust, and very little about the dangers from draughts of air to which pupils are exposed in many schools. Catarrh with aural complications results from this cause.

A large experience has led the author to believe that great injustice is being done in permitting children to struggle for an education, under the disadvantages arising from deafness, without the aid of methods which experience has shown to be advantageous in such cases. He found 76 cases of deafness in 570 pupils examined in the public and parochial schools of New York City; while, of this large number of children, but one was known to the teachers as suffering from deafness, and only nineteen were aware that they were deaf. As a result of Dr. Sexton's labors, teachers are much interested in the subject, and find that deafness explains many cases of supposed 'inattention' and 'stupidity.' The author states that careful estimates show that only five per cent of the population of the United States have normal hearing. He finds deafness to exist to a certain extent among teachers as well.

A chapter is devoted to the effect of high atmospheric pressure on the ear in tunnels, caissons, etc., which contains illustrative cases, some of the injuries being produced in the Hudson River Tunnel, and one in the caisson of the Harlem River Bridge. The injurious effects of unskilful treatment in the removal of foreign bodies from the ear are described. There can be, he says, no more pitiable object than a child, terror-stricken and exhausted with fear, struggling in a frenzied way while the ear is painfully lacerated in unskilful attempts at the removal of a foreign body. This operation should only be done by one skilled in the proper methods.

The claims of soldiers, sailors, and marines for pensions on account of disability from deafness is the topic discussed in the final chapter. Under the present law, thirteen dollars per month (a full pension) is the whole amount allowed for total or severe deafness of both ears, with a proportionate amount for partial loss of hearing in one or both ears. On March 1, 1886, 1,230 persons were drawing pensions for total deafness, and 4,159 for partial deafness, — a total of 5,389. A table is given showing the rates of payment, with the aggregate for each State and Territory. Fifty-nine illustrations and a copious index add much to the value of this excellent work.

Town and Country School Buildings. By E. C. GARDNER. New York and Chicago, E. L. Kellogg & Co. 12°.

THIS book is inexpensive and it is unpretentious, but it is full of valuable suggestions. Our schools, especially in the rural districts, are generally buildings of consummate ugliness and inconvenience. The village carpenter builds them, box-like, and is satisfied. It costs no more, however, to build an attractive and well-arranged school than the opposite, if only the builders are shown how to do it. Mr. Gardner's little book serves this purpose admirably. By cuts and diagrams, and by specific building directions, the subject is presented in an attractive and practical way. The book should be often consulted by district school trustees.

Macmillan's Greek Reader. By F. H. COLSON. London and New York, Macmillan. 16°. 75 cents.

A Latin Reader. By H. J. HARDY. London and New York, Macmillan. 16°. 60 cents.

MR. COLSON'S 'Greek Reader' is an attempt to give a collection of stories in Attic Greek taken from originals. As the Greek authors whose writings contain anecdotes, historical and mythological, which form so suitable a subject-matter for school-exercises, belong to a later period, they do not form a good introduction to the study of the great Attic prose writers. On the other hand, such readers as contain interesting stories, that are taken from any source and turned into Greek, labor under the disadvantage that the material is not original, but a translation. The author has avoided this difficulty by selecting stories Greek in substance and form, but simplified, and adapted to the form of ordinary Attic Greek. The stories are arranged by subjects, not as to their difficulty, but the more difficult ones have been marked by asterisks. A full vocabulary and exercises are contained in the volume.

Mr. Hardy's 'Latin Reader' consists of Latin stories taken from Latin authors and other sources. An attempt has been made to gather compact and intelligible stories, the subjects of which may be expected to interest the average schoolboy. These stories are intended for the ordinary reading of boys who are not yet sufficiently far advanced to read Latin authors continuously. They conclude with some pieces taken directly from the authors which will naturally form the next stage; otherwise all the stories are intended for the lower forms of schools. A useful vocabulary is appended to the book.

NOTES AND NEWS.

THE American Institute Fair, which will close early in next month, attracts attention, as it well deserves, from the resident New-Yorkers and those who visit the city. The exhibition hall, at Sixty-third Street and Third Avenue, is convenient of access by the elevated railways and street-car lines. With the building filled with a variety of exhibits, covering almost every branch of industry, and the machinery hall containing about one hundred different exhibits, and a Corliss engine working without fault, and pronounced by competent judges to be as fine a piece of mechanism as has ever been seen even in New York, and with an art department complete, and household exhibits without number, — and all this at the reduced admission of twenty-five cents, — there is no reason why an investment of money and an investment of time to visit the fair should not be made, and good return received for going. The building is open from 10 A.M. to 10 P.M.

— G. Gröber's *Grundriss der romanischen Philologie* has now arrived at its third number, which completes the first volume. The work, which is published by Trübner at Strassburg, is a cyclopedic collection of grammatic, literary, and paleographic articles upon

the Neo-Latin languages of southern Europe, contributed by twenty-five specialists. The originator and digester of this literary enterprise has evidently secured the best talent obtainable for the purpose, and the wealth of information contained in the 853 pages of the handsome volume is simply overwhelming. The almost infinitely numerous dialects are examined as carefully as the literary form of each Romance language, and whole pages are devoted to the history and literary history of the dialects, and the metrics, stylitics, and philologic transmission of the principal languages from their earlier stages down to our times. Attention was also paid to those extinct tongues which have or may have influenced the formation of the Neo-Latin languages, as Oscan, Umbrian, Etruscan, Celtic, Basque, etc. Prof. G. Gröber, W. Schum, A. Tobler, and others have furnished treatises of more general import upon Romance studies, whereas the French and Provençal was treated grammatically by H. Suchier, Italian by Fr. d'Ovidio and W. Meyer, and Spanish by G. Baist. The second volume will be devoted especially to the history of the different literatures of the Romance tongues.

— Beginning Jan. 5, Prof. W. O. Crosby will give a course of ten lessons before the Teachers' School of Science of the Boston Society of Natural History.

— The Geological Survey of Kentucky has just published a report on Bath and Fleming Counties by W. M. Linney, which is accompanied by a good geological map. A detailed geological description of the counties, and notes on their mineral products, mineral waters, and agricultural resources, are given. An appendix contains notes on the rainfall at Sharpsburg from January, 1859, to September, 1885. The Preston Ore Banks in Bath County are treated at some length.

— The New England Meteorological Society proposes to have a loan exhibition of meteorological apparatus, photographs, etc., at the Institute of Technology, Boston, in connection with its fourteenth regular meeting in January, 1889. For this purpose the society invites contributions of meteorological apparatus, photographs, and charts and specimens. Articles should be sent to A. Lawrence Rotch, Massachusetts Institute of Technology, Boston, by prepaid mail or express, not later than Jan. 12, 1889, and preferably immediately. Communications regarding the exhibition should be marked "Loan Exhibition," and addressed to A. Lawrence Rotch, Blue Hill Observatory, Readville, Mass.

— The American Forestry Congress convenes at Atlanta, Ga., on the 29th of November, and the annual meeting of the Association of Agricultural Colleges and Experiment Stations occurs at Knoxville, Tenn., Jan. 1.

— Notwithstanding the considerable difficulties which have been met with in the digging of a canal to connect the Obi with the Yenisei, and the want of money for the completion of the undertaking, the work of connecting the two great arteries of navigation in Siberia is still advancing. *Nature* says that in the summer of the present year a boat 56 feet long and 14 feet wide, taking 3½ feet of water, was drawn from the Obi into the Yenisei with a load of 40 tons of flour. The two rivers are 630 miles apart.

— N. M. Prjevalsky, the famous explorer of Central Asia, died at Vyernyi when preparing his fifth expedition to Tibet. Prjevalsky, in his four expeditions to Central Asia, has laid the foundation of our knowledge of these remote regions. On his first expedition he explored Mongolia and the country of the Tangutes. The Russian Geographical Society awarded him the great Constantine medal for this expedition; but, however important the results were to the science of geography, they were far excelled by those of the second expedition, on which he rediscovered the Lob-nor. His principal aim in all these journeys was to reach Lhassa. On his third journey, when the obstacles presented by deserts and difficult mountain-ranges were overcome, and the explorer was approaching Lhassa, he had to turn back, as the Dalai Lama forbade him to enter the great Buddhistic capital. On his fourth journey he explored the upper Hoangho, but was unable to penetrate into Tibet. He returned by way of East Turkestan. The object of his fifth journey was to reach Lhassa, and it appeared as though the political situation would be favorable to the enterprise. His untimely death will be regretted by all geographers. Prjevalsky was only in his fiftieth year. His energy and love of travel and exploration were indomitable, and undoubtedly important results would have accrued from his further work. He has shown how to explore the highlands of Central Asia; and, although he himself is gone, he leaves a number of enthusiastic followers, who have accompanied him during his journeys, and who will undoubtedly continue his great work.

— *The Open Court* of Nov. 15 contains a discussion of 'The Marriage Problem,' by Prof. E. D. Cope. —— In the December number of *The Chautauquan* are to be found 'Gossip about Greece,' by J. P. Mahaffy, M.A., of Dublin University; 'Pericles,' by Thomas D. Seymour, M.A., of Yale University; 'Greek Mythology,' by James Baldwin, Ph.D.; 'Sunday Readings,' selected by Bishop John H. Vincent, D.D., LL.D.; 'The Circle of the Sciences,' by Prof. A. P. Coleman, Ph.D., of Victoria University; 'The Indians of the United States,' by J. B. Harrison; 'The Red Cross,' by Charles Barnard; 'The Bessemer Steel Rail,' by J. C. Bayles; 'The Charities of Buffalo,' by J. W. Bashford, Ph.D.; 'Count Tolstoï's Theories,' by Anatole Leroy-Beaulieu; 'The Yankee Privateer,' by Arthur Hale; 'Lost Explorers and Expeditions,' by Lieut. Frederick Schwatka; 'The Moravian Mecca,' by Bishop John F. Hurst, LL.D.; 'Talks on Memory,' by Prof. Wilbert W. White; 'Louisa May Alcott,' by Harriet Prescott Spofford; 'Scientific Temperance' (a symposium of letters from eminent physicians), and 'The Dinner of Callias,' translated from the *Symposium* of Xenophon, besides the usual editorial and C. L. S. C. departments. —— The Saranac and Lake Placid regions of the Adirondacks, as they appear in mid-winter, will be described in the Christmas *Scribner's* by Hamilton Wright Mabie.

— A vocabulary to the first six books of Homer's 'Iliad,' by Prof. Thomas D. Seymour of Yale College, is to be published in March, 1889, by Ginn & Co. This vocabulary has not been compiled from other dictionaries, but has been made from the poem itself. The maker has endeavored to be concise, — to give nothing but what is important for the accurate and appreciative reading of the 'Iliad,' — and yet to show the original and derived meanings of the words, and to suggest translations which should be both simple and dignified. A confident hope is felt that the concise form of this vocabulary will save much time for the beginner in Homer. More than twenty woodcuts, most of which are new in this country, illustrate the antiquities of the 'Iliad.' —— D. C. Heath & Co. have recently issued 'Hodgkin's Studies in English Literature,' which gives full lists of aids for laboratory method (a separate pamphlet is issued for each author); 'Fontaine's Historiettes Modernes,' Vol. I., being short and easy stories for beginners; and 'Van Daell's Leander's Mærchen,' with notes for elementary or rapid sight-reading. The same firm will soon add to their series of French texts for schools and colleges, 'La Belle Nivernaise, Histoire d'un Vieux Bateau et de son Equipage,' by Alphonse Daudet, with 6 illustrations; and 'Bug Jargal,' by Victor Hugo, — both edited by James Boïelle, senior French master at Dulwich College, England; also Scribe's 'Le Verre D'Eau' and Lamartine's 'Jeanne D'Arc' (these last are to be edited by A. Barrere, professor of modern languages in the Royal Military Academy, Woolwich, England); also a translation of Paolo Mantegazza's 'Testa, a Book for Boys,' — a companion book to DeAmicis's 'Cuore.' The translation will be made under the supervision of Prof. L. D. Ventura of Boston, and of the Sauveur Summer School of Languages. —— Messrs. Ginn & Co. will have ready about Dec. 15 a new edition of Allen & Greenough's 'Latin Grammar.' The revision of eleven years since has stood the tests of every-day use; but from the day of its publication the book has been studied to find where it could be made better in either great or little points, and the results of this study are given in the present revision. With Collar and Daniell's 'Beginner's Latin Book,' the new 'Grammar' and the new 'Cæsar,' 'Cicero,' and 'Virgil,' followed and supplemented by Collar's 'Practical Latin Composition' (now in the printer's hands), and the forthcoming College Series of Latin Authors, with many other texts, teachers in this department will find most serviceable Latin text-books.

— 'The Old Northwest: with a View of the Thirteen Colonies as constituted by the Royal Charters,' by B. A. Hinsdale, Ph.D., constitutes No. 2 of Mac Coun's Standard Historical Series. 'The Old Northwest' is a guide to the historical facts of State, Federal, and Inter-State legislation in connection with their formation, development, and admission into the Union. —— P. Blakiston, Son, & Co. have just published a second edition of 'Medical Jurisprudence and Toxicology,' a text-book for medical and legal practitioners and students, by John J. Reese, M.D.; and 'The Physician's Visiting List for 1889,' being the thirty-eighth year of Lindsay and Blakiston's 'Physician's Visiting-List.'

LETTERS TO THE EDITOR.

Anemometer Constants.

THE last volume of the *Repertorium für Meteorologie* (Vol. XI. No. 7), just received, contains a paper by Dubinsky ('Vergleichende Verification zweier Anemometer in Hamburg, Deutsche Seewarte, und in St. Petersburg, Physical Central-Observatorium'), giving the results of comparative tests of two Robinson anemometers of very small dimensions, and using for this purpose the two whirling-machines respectively at Hamburg and St. Petersburg.

These experiments are of special interest to the writer, who was himself engaged during the past summer upon similar work for the Signal Service, and used, with the larger anemometers of the service, a very small one for studying certain parts of the problem. In this work the whirling-machine was very large, having an arm twenty-eight feet long, which in later experiments was increased to thirty-five feet. It is not intended at this time to speak further of this work, but to notice in a few remarks the method (pp. 11 *et seq.*) used by Mr. Dubinsky to ascertain a very important correction, and to compare his results with those obtained by Dohrandt (*Rep. für Met.*, Vol. IV.–Vol. VI.), who had already used the St. Petersburg machine in making a large number of experiments upon anemometers of the ordinary sizes.

The two whirling-machines, which are permanently set up in closed rooms, are nearly the same in size; that at St. Petersburg being much like a letter T in form, and adapted to be revolved about the central stem as an axis, carrying the anemometer to be tested on the outer end of one or the other of its horizontal arms, which are about eleven feet long. In the Hamburg machine one arm is quite short, and carries a counterpoise; the other is between twelve and thirteen feet long.

In using such whirlers, there is a tendency of the arm and other moving parts to set up a slow rotation in the air, as a whole, through which they revolve. This movement of the air with the arm is called by the Germans, and aptly so, the *Mitwind*. The determination of its amount is one of the most serious obstacles to overcome in experiments of this kind.

Results seem to indicate a pretty close proportionality of this *Mitwind* to the velocity of the arm; and Dohrandt concluded from his studies that in value it was about 5 per cent of the latter. Dubinsky, working with relatively very much smaller anemometers, though using the same whirling-machine, adopts 7.3 per cent as the correction for the *Mitwind*. The discrepancy in these results is really larger than it appears, when it is considered how much less the small anemometers would tend to generate *Mitwind*, as compared with those used by Dohrandt.

A brief description of the method of measuring the *Mitwind* will aid in understanding the question. For this purpose both experimenters placed close to the path of the whirled anemometer a delicate air-meter, with its axis tangent to the orbit. Its indications during the progress of an experiment give a measure of the *Mitwind*, however, being strongly acted upon by the violent disturbance of the air which immediately attends and follows just after the passage of the whirled anemometer, and which cannot be considered as a true *Mitwind*. The velocity given by the air-meter is no doubt, as Dohrandt points out, much greater than that of the true *Mitwind*.

The treatment by Dubinsky, of this observed velocity, to reduce it to the *Mitwind* velocity, is practically the same, at least in intent, as the expedient resorted to by Dohrandt (*Rep. für Met.*, Vol. IV. No. 5, p. 39), who placed on the end of the unoccupied arm of the whirler a small air-meter, which was thus carried in the path of, but diametrically opposite, the whirled anemometer. The whirling-machine is revolved, first with both anemometer and air-meter in position, and then with the air-meter alone. Owing to a decrease in the *Mitwind* attending the removal of the anemometer, the whirled air-meter registers a larger number of units in the second case than in the first; and the difference, in terms of velocity, is considered by Dohrandt as the *true value* of the difference between the *Mitwinds* in the two cases. Not questioning the correctness of this assumption, a comparison of the difference thus obtained with that derived from the indications of the stationary air-meter shows the latter to be from two to three times the former or presumed true difference. Finally, it is further assumed that the whole observed *Mitwind* and the true are in the same proportion. Or, if v_1 and v_2 are the velocities indicated by the air-meter when whirled with and without an anemometer, and x_1 and x_2 the corresponding velocities of observed *Mitwind*, we have, the velocity of the arm being the same in both cases,

$$\frac{v_2 - v_1}{x_1 - x_2} = a;$$

and the true *Mitwind* is $a \times$ observed *Mitwind*.

In applying this method, Dubinsky whirled both of the small anemometers, one on each end of the arm, and then one alone, using the stationary air-meter for observing the *Mitwind* in each case. This substitution of the small anemometer — an instrument equally influenced by equal winds in a horizontal plane, whatever their direction — for an air-meter not thus influenced, is an important modification of Dohrandt's method, and may serve to account for a part, at least, of the difference found in their results. Dubinsky has, apparently without being aware of its peculiar merits, hit upon what is believed to be a more proper method of investigating *Mitwind* than any heretofore used: that is to say, the *Mitwind* anemometer must be of the same form as the anemometer being tested, as it is evident the instrument used for measuring the *Mitwind* must be influenced thereby in the same manner, and to the same extent, as the instrument whose constants are being determined.

Throughout the tests upon the small anemometers the *Mitwind* was carefully observed by means of a stationary air-meter, and 7.3 per cent of the arm-velocity was adopted as its value at St. Petersburg, 7.6 per cent being the value found at Hamburg. A single experiment only is cited, by which the value of the factor a was determined, and is as follows: —

	v_0 Velocity of Arm. Kilometres per Hour.	c Contacts per Hour of Anemometer No. 74.	x Mitwind. Kilometres per Hour.
With both anemometers	62.24	60.04	4.91
With No. 74 alone	62.56	60.56	4.68

The paper further states that in the second case, had the velocity of the arm been 62.24 instead of 62.56, the recorded contacts of No. 74 would have been 60.27. Hence we have

	v_0	c	x
	62.24	60.04	4.91
	62.24	60.27	4.68
Differences		0.23	0.23

The author, apparently too hastily, jumps at the conclusion, and places

$$\frac{0.23}{0.23} = 1.00$$

as the value of the factor a, and in consequence applies all of the 7.3 per cent observed *Mitwind* as the correction for that disturbance. It is to be observed that the first 0.23 in the line of differences is in terms of *contacts per hour*, and is not a velocity. Further

uncertainty arises in that the value 60.27 seems itself a little abnormal.

Referring to the equation found for this anemometer on this machine, we have,

$$v = 0.910 + 1.02729\,c - 0.00076\,c\ ,$$

from which, when $c = 60.4$,

$$\frac{dv}{dc} = 0.935.$$

Using this co-efficient to reduce the contacts observed in the second case to those corresponding to the velocity 62.24 of the first case, we have 60.22 contacts as the number per hour. To be accurate, the observed *Mitwind* in the second case should also be reduced to the velocity of the first case. Preserving its proportionality to the arm-velocity, we find its value to be 4.67 kilometres per hour. Hence it seems we should have

	v	c	x
	62.24	60.04	4.91
	62.24	60.22	4.67
Differences		0.18	0.24

Using the co-efficient 0.935 to reduce contacts per hour to kilometres per hour, we have corresponding to 0.18 contacts per hour a velocity of 0.17 kilometres per hour. Hence finally,

$$\frac{v_2 - v_1}{x_1 - x_2} = \frac{0.17}{0.24} = 0.71 = a.$$

The true *Mitwind*, according to this value, would be 5.2 per cent, —a value practically the same as that found by Dohrandt; namely, 5 per cent. Considering that the latter value applies to much larger anemometers than the former, the still outstanding difference is probably due to the point already noted, that in the recent experiments a Robinson anemometer, and not an air-meter, was used. Further light would no doubt be thrown upon the question of the value of the *Mitwind*, if experiments were made in which the stationary air-meter is replaced by a small and very sensitive Robinson anemometer.

It is hardly probable that the *Mitwind* is strictly tangential to the path of the whirled anemometer: indeed, the writer has observed a marked tendency to a spiral motion of the air and air-meters with their axes tangent to the circular paths of the end of the whirling arm,—get, as it were, only the tangential component.

These considerations, it would seem, throw more or less doubt upon the accuracy of the *Mitwind* corrections as obtained by both experimenters, though in each case the results agree very well among themselves. Unfortunately Mr. Dubinsky does not give the numerical relations between the 'contacts' and the revolutions of the cups, by which it becomes possible to make comparisons with anemometers of different construction in this respect.

C. F. MARVIN.

Washington, D.C., Nov. 12.

A Telescope for the New Astronomy.

AS we become accustomed to celestial phenomena, we find a large number of faint appearances, upon the interpretation of which our knowledge of the forces at work depends: for instance, the detection of the carbon atmosphere surrounding the sun, foreshadowed by Archimis in 1875 by the detection of the bright carbon band in the blue in the spectrum of the zodiacal light, inferred by Lockyer in 1878 from a comparison of the solar and electric arc spectra, indicated also by the observations of Schuster at Sohag and by Abney in 1881, and finally worked out line by line by the large instruments and photographic methods of Rowland; or, again, the faint bright lines detected in the spectrum of many stars, affording new ideas both as to the cause of the variability of the stars' light and the classification of stellar spectra as worked out from the study of meteorites by Lockyer. We find also that we are not dealing with constant things: change and change again are the only law. As the gravitational astronomer reaches his conclusions by following the changing positions of the heavenly bodies, so the physical astronomer must watch its ever-changing appearance. Recall to mind the discussion over the well-known comet spectrum, one astronomer averring from personal observation, deserving great respect, that the line belonged to the carbonic-oxide spectrum, while his rival assured us from equally trustworthy sources that it was nothing if not hydrocarbon. Science to-day tells us both were right, a slight change in the density of the gas being sufficient to change the spectrum from one to another. Our knowledge is therefore far from complete till we have substituted the series for the single observation.

But the human eye and the human brain are not sufficient — nay, are sometimes misleading — when complete and accurate detail are desired. Our attention is attracted by the points raised by the current theories of the day; and much is left unnoticed, or, if sought, is missed because one did not know where to look. The history of the discovery of the solar prominences, easily seen, after discovery, by the same observer, using the same telescope with which he had previously been unable to discover their existence, presents an example. Photography to-day supplies a remedy. In the hands of a master skilled both in the manipulation of the emulsion and the dye, its effect is not slight; its advantage, much the same as a balloon would give the voyager in the frozen seas, — showing at a bird's-eye glance what years of travel could not show. By it we may carry our best telescopes and our best seeing into every home and school-room; forming in his very youth the astronomer of the future, who shall work without telescope or observatory; rendering him familiar with those appearances which, not so many years ago, enchained his ancestors.

From its scientific side, of what great value has the chance delineation of the tails of comets been in the hands of Bredechin?

It is not every telescope which is fitted to this end. It must be pre-eminently a light-gatherer, which demands a large-sized object-glass, with the attendant mounting, and yet possess the ease and accuracy of motion of a sylph. It must be of great length, — thirty-five or forty feet, — and yet from end to end have no mass of metal which could produce an air-tremor. Yet such an instrument — the El Dorado of full many an astronomer — to-day grows in the workshop of an English astronomer.

Seven feet in diameter, and of great thickness, is the reflecting mirror; forty feet, its length from end to end. Yet tube it has practically none. Tons in weight, it follows the steady pressure of your little finger. Pedestal it has none, but floats upon its polar axis like a large warship; this polar axis being little else than a large boiler, so arranged, that, "should it be thrown into the sea in a given latitude, it would still point its axis to the pole."

With an instrument of less than a fifth its power, Common's well-known photograph of the nebula in Orion was taken. With one of less than a seventh of its capacity, the nebula in the Pleiades was discovered. The wonders reported from Mount Hamilton show us what we may expect it to disclose.

The instrument is secured to us through the *esprit* of a well-known astronomer. Is it not possible that among the readers of your journal may be found many who would contribute something towards its endowment? Of all our observatories, there is none that is popular. Can we not make the largest glass the world has yet seen popular?

S. O.